SOURCE OF THE OPTICAL RED-SLOPE IN IRON-RICH METEORITES. Daniel T. Britt, Carle M. Pieters, and Peter H. Schultz, Department of Geological Sciences, Brown University, Box 1846, Providence, RI 02912.

The relationship between ordinary chondrites and the S-type asteroids is an unresolved issue in meteorite science. S-type asteroids exhibit a positively red-sloped spectrum that has been interpreted to indicate the presence of elemental iron on their surfaces. Some workers [1] suggest that S-type asteroids represent undifferentiated parent bodies of ordinary chondrites on which regolith processes have enhanced the spectral signature of metallic iron relative to laboratory samples. Other workers [2] interpret the red-slope spectra in S-types to indicate the presence of relatively large amounts of elemental iron and suggest that the differentiated meteorites are better analogs. The issue hinges on the amount and form of iron required to produce a spectral red-slope.

Investigators using integrating-sphere spectrometers [3] note that iron-rich meteorites exhibit a strong and characteristic red-slope in the visible and near-infrared wavelengths. Optical constants measured at normal incidence for iron [4] and for iron-nickel alloys [5] also predict a red-sloped spectrum. The effect of viewing geometry on the reflectance of iron meteorites has been investigated using NASA's RELAB facility located at Brown University [6]. Figure 1 shows the spectra of a clean, smooth portion of a nickel-iron meteorite taken from several viewing geometries (these data are relative to the reflectance of halon and are displayed on a logarithmic scale). A striking feature of these results is that iron's characteristic red-slope appears only in the specular portion of the reflectance. All the non-specular geometries exhibit flat, featureless spectra with the relative brightness being a function of the angular distance from the specular reflection. These results suggest that the diffuse reflectance spectrum of iron and any iron-rich complex surface is a weighted average of specular and non-specular components; the degree of "redness" is a function of the amount of the specular component included in the measurement. As a test of this hypothesis, bi-directional spectra were obtained of a complex iron surface (an 8 mm crater produced in an experimental hypervelocity, metal on metal, impact on the same iron meteorite [7]). The spectrum of the crater on the meteorite exhibit a red-slope of 30%. The proportions of shadow and specular, near-specular, and non-specular reflectance were estimated for the meteorite crater, and a linear mixing model was applied using the spectra of figure 1. Less than 0.2% of the specular component was required to accurately model the red-slope of the meteorite crater.

CONCLUSIONS: The characteristic red-sloped spectrum of iron-rich meteorites is produced by only the specular component of the reflectance. Complex metallic surfaces can be modeled as linear mixtures of specular and non-specular components. It is the geometry of the metal on a surface and its interaction with surrounding material, rather than the absolute amount of metal, that determine the redness of resulting spectra. In order to distinguish between ordinary chondrite and differentiated parent bodies it is important to understand how regolith processes affect the nature and form of metal on asteroid surfaces.

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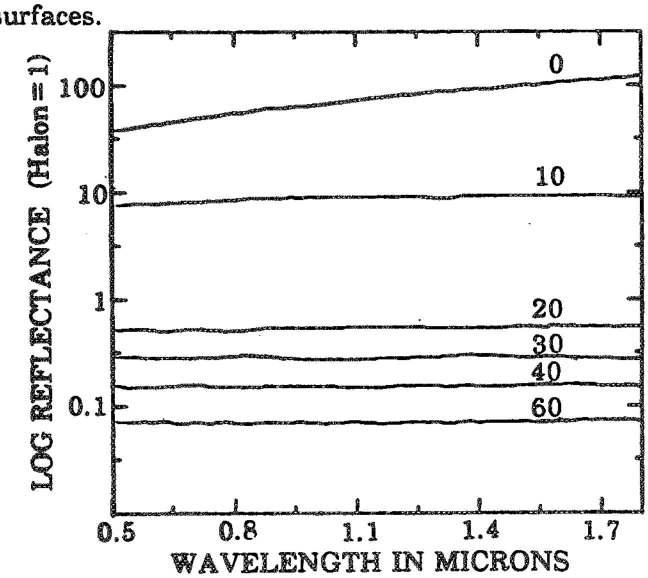

FIGURE 1: Bi-directional reflectance of iron meteorite sample. Labels are in degrees from specular reflection.